

## CLAIMS

What is claimed is:

- 1           1.       A pixel-registered photo detector array comprising:  
2               one or more detector layers of semiconductor material, each detector layer between  
3               contact layers of semiconductor material, thereby defining a stack of layers  
4               having a front side and a back side; and  
5               a waffle-type light-coupling grating formed on the backside of the stack, the grating  
6               having a pattern of holes that reflects a substantial portion of light coming  
7               into the array so as to disperse that light through the one or more detector  
8               layers, thereby facilitating absorption.
- 1           2.       The array of claim 1 wherein the pattern of the waffle-type light-coupling  
2               grating has a geometry optimized for a center wavelength of interest, and an orientation  
3               ranging from about 20 to 70 degrees.
- 1           3.       The array of claim 2 wherein the geometry includes a hole depth of about  
2               one quarter wavelength of the center wavelength of interest, and a spacing between the  
3               holes of about the center wavelength of interest.
- 1           4.       The array of claim 2 wherein the orientation is about 45 degrees.
- 1           5.       The array of claim 1 wherein the array has a plurality of detector layers,  
2               each having a different light absorption versus wavelength response curve thereby enabling  
3               a multicolor photo detector.
- 1           6.       The array of claim 1 wherein edges of the one or more detector layers are  
2               reflectively coated so as to provide, in conjunction with the waffle-type light-coupling  
3               grating, a photon-in-a-box configuration for containing light within each pixel of the array.
- 1           7.       The array of claim 1 wherein the waffle-type light-coupling grating includes  
2               a hybrid metal layer having both ohmic and reflective qualities.

1           8.     The array of claim 1 wherein each of the one or more detector layers is  
2     about one micron or less in thickness.

1           9.     The array of claim 1 wherein each of the contact layers is electrically  
2     coupled to a respective electrical contact on the backside, thereby facilitating hybridization  
3     where the array is connected to a substrate configured with supporting electrical circuitry.

1           10.    The array of claim 1 wherein the array is configured as a strained-  
2     InGaAs/AlGaAs QWIP structure having a limited number of quantum wells so as to enable  
3     exploitation of avalanche effects.

1           11.    A pixel-registered photo detector array comprising:  
2             one or more detector layers of semiconductor material, each detector layer between  
3             contact layers of semiconductor material, thereby defining a stack of layers  
4             having a front side and a back side;  
5             a light-coupling grating formed on the backside of the stack with a hybrid metal  
6             layer having both ohmic and reflective qualities, and having a pattern that  
7             reflects a substantial portion of light coming into the array so as to disperse  
8             that light through the one or more detector layers, thereby facilitating  
9             absorption;  
10            wherein edges of the one or more detector layers are reflectively coated so as to  
11            provide, in conjunction with the light-coupling grating, a photon-in-a-box  
12            configuration for containing light within each pixel of the array.

1           12.    The array of claim 11 wherein the pattern of the light-coupling grating is a  
2     waffle-type grating and has a geometry that includes a hole depth of about one quarter  
3     wavelength of a center wavelength of interest, and a spacing between the holes of about the  
4     center wavelength of interest.

1           13.    The array of claim 11 wherein the pattern of the light-coupling grating has  
2     an orientation of about 45 degrees.

1           14.    The array of claim 11 wherein the array has a plurality of detector layers,  
2   each having a different light absorption versus wavelength response curve thereby enabling  
3   a multicolor photo detector.

1           15.    The array of claim 11 wherein each of the one or more detector layers is  
2   about one micron or less in thickness.

1           16.    The array of claim 11 wherein each of the contact layers is electrically  
2   coupled to a respective electrical contact on the backside, thereby facilitating hybridization  
3   where the array is connected to a substrate configured with supporting electrical circuitry.

1           17.    A pixel-registered photo detector array comprising:  
2           one or more detector layers of semiconductor material, each detector layer between  
3           contact layers of semiconductor material, thereby defining a stack of layers  
4           of a multicolor photo detector having a front side and a back side;  
5           a rotated light-coupling grating formed on the backside of the stack, the light-  
6           coupling grating having a pattern that reflects a substantial portion of light  
7           coming into the array so as to disperse that light through the one or more  
8           detector layers, thereby facilitating absorption.

1           18.    The array of claim 18 wherein the rotated light-coupling grating has an  
2   orientation of about 45 degrees, and has one of a waffle-type or post-type pattern.

1           19.    The array of claim 18 wherein the light-coupling grating includes a hybrid  
2   metal layer having both ohmic and reflective qualities, and edges of each detector layer are  
3   reflectively coated so as to provide, in conjunction with the light-coupling grating, a  
4   photon-in-a-box configuration for containing light within each pixel of the array.

1           20.    The array of claim 18 wherein the array is configured as a strained-  
2   InGaAs/AlGaAs QWIP structure having a limited number of quantum wells so as to enable  
3   exploitation of avalanche effects.